The Tragedy of the Commons and High Seas Fishery Management

Max Benson Cassidy
Haverford College
Department of Economics
Advisor: Vladimir Kontorovich
Spring 2013

Abstract

High seas fisheries have been at the forefront of the debate on how to best manage common-property resources over the past few decades as conservation concerns have grown. Studies show that the North Atlantic bluefin tuna stock has steadily declined since governments first began recording catch totals about fifty years ago, and in the late 1990s, scientists believed the North Atlantic swordfish fishery was near collapse. This paper first explains the economic theory of the tragedy of the commons, and discusses different common-property management systems, specifically focusing on adaptive governance. The adaptive governance framework is then used to analyze the cases of the North Atlantic bluefin tuna and the North Atlantic swordfish, attempting to determine how the swordfish stock has rebounded while the bluefin tuna continues to decline. The findings are that the swordfish fishermen were able to collaborate with management whereas that has not been true in the case of the bluefin tuna. High seas fishery management will continue to be debated until a management system is able to clearly define the boundaries of the common-property resource.

Table of Contents

Section *Page Number*

Introduction

There are many types of resources that people of all walks of life depend on, and some are distributed throughout the world in such a way that many people have access to them – generally referred to as common-property resources[1] (CPRs). A CPR can be natural, such as a fishery, or man-made, like an irrigation field, where excluding or even limiting users is very difficult. Exclusion can be a problem because once one user has appropriated a resource unit, it is unavailable to any other user (E Ostrom et al 1994). CPRs are often discussed concerning their respective management regimes in order to determine whether the resource is public or private property, because economists, political and social scientists, and policymakers have yet to determine the optimal system. Some advocate certain governance systems, such as state or private management, which is essentially transplanting a management blueprint from one CPR to another. Others argue that each CPR is unique and requires a custom governance system, known as adaptive governance.

This paper aims to highlight the shortcomings of the former argument, and to use a general framework to examine the histories of two similar CPRs in order to determine why one management regime has been successful[2] while the other has not. The first section of the paper explains the economic problem inherent in common-property resources; the second section critiques certain management regimes; the third defines the institutional framework; and the final portion of the paper examines two similar CPRs

[1] The term common-property resource is synonymous with common-pool resource.

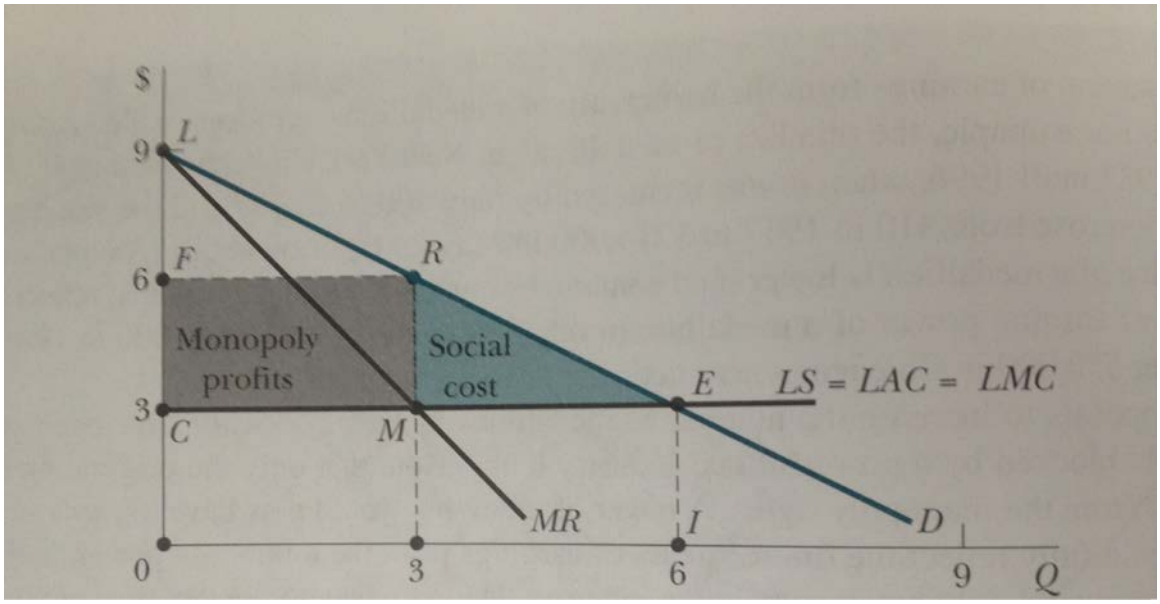
[2] Successful here refers to when "institutions that enable individuals to achieve productive outcomes in situations where temptations to free-ride and shirk are ever present." (Ostrom 1990)

and attempts to determine why one management system was successful while the other has yet to show signs of improvement.

I. The Tragedy of the Commons

Aristotle once stated, “What is common to the greatest number gets the least amount of care.” The economic consequence of this phenomenon is what is known as rent dissipation. Rent, in this case resource rent, is the difference between the sale price and the cost to produce the resource unit. Consequently, rent dissipation is a situation where the resource has been harvested to the point where the users collect less and less resource rent. Garret Hardin’s 1968 paper, “The Tragedy of the Commons,” was the first to explain this socio-economic problem of rent seeking in relation to common property. Hardin uses the example of a pasture and herdsman where each herdsman, “as a rational being,” tries to maximize gains.

Figure 1.1:



This scenario can also be described using the simple monopoly graph[3] above (Salvatore 2003) where the long run supply (*LS*) is equal to the long run average cost (*LAC*) and long run marginal cost (*LMC*). The measurement unit on the *y*-axis is dollars and that of the *x*-axis is the quantity of the resource harvested. The demand curve (*D*) represents the average productivity of the fishermen. Maximum economic yield, the maximum obtainable resource rent, is shown in the gray shaded box *FRMC* and is produced when the quantity harvested is equal to *3*.[4] However, according to economic theory, users will seek to harvest *6* units because they each attempt to maximize profits. These profits attract users to the system in order to earn a portion for themselves, thereby increasing the fishing effort. The increase in fishing effort causes the available profit to be divided between more users, effectively eliminating profit from the system. Users will continue to be attracted to the system until there is no more profit available, which is why the equilibrium in Figure 1.1 is point *E*.

The equilibrium point *E* corresponds to what is known as the maximum sustainable yield. Maximum sustainable yield is the amount that can be harvested from a resource without reducing the base stock, essentially harvesting the same quantity that is added back to the resource through spawning. Scientists attempt to determine the maximum sustainable yield of the resource which is then used by management to allocate fishing effort, for example by issuing quotas or limiting the number of days in the fishing season. The problem inherent in this situation is that the fishing effort corresponding to maximum economic yield is less than that which corresponds to the maximum sustainable yield. In an open-access fishery the fishing effort corresponding to maximum

[3] The terms “Monopoly profits” and “Social costs” should be ignored.
[4] The numbers have no numerical significance, just for explanatory purposes.

economic yield is not sustainable because it is not the equilibrium point. The profit shown by *FRMC* would dissipate as users outside of the CPR enter the fishery in order to gain a portion of their own, continuing until the system reached point *E*. This examination shows that the main question in determining a successful CPR management system is how do you restrict or cap fishing effort? The answer to this question is the solution of the tragedy of the commons. If user access is restricted then there will be no opportunity for external users to be attracted to the profits of the CPR; and if these external users are restricted then there will be no increase in effort to dissipate the resource rent of the CPR.

Figure 1.2:

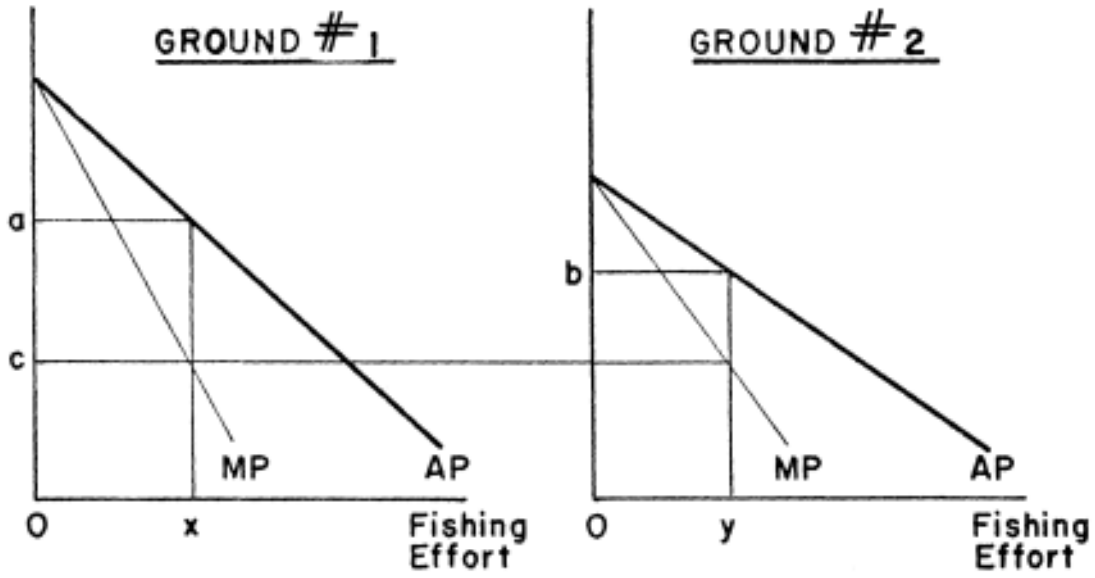


FIG. 2

The above two graphs (Gordon 1954) help to describe the commons problem further. Ground #1 has a higher average productivity (*AP*) than Ground #2, meaning the same level of fishing effort in both grounds will yield a higher total output from Ground #1. In order to maximize profits in both grounds, fishing effort *x* must be allocated to

Ground #1 and *y* effort to Ground #2. In this scenario, fishermen using Ground #1 will split a profit of *x*(a-c)*, and those using Ground #2 will split a smaller profit of *x*(b-c)*. The problem in doing this when referring to the commons is that fishermen are free to fish where they choose, and fishermen are solely concerned with maximizing their profits. Therefore, the fishermen will choose to fish the ground with a higher average productivity, the ground with more fish will provide a better chance of maximizing their profit. Users of Ground #2 would therefore shift to Ground #1 until potential profit was equal across grounds, creating a stable equilibrium (Gordon 1954). This outcome is not maximizing the resource rent, which should be one of the goals of a CPR management regime.

Hardin's paper influenced the line of thinking that users were incapable of solving this commons problem without the help of external agents. He argues that rational beings, all users of a given CPR, are trapped in this system of rent seeking where they will increase their efforts to no end until rents have dissipated. "Once they [the users] see the necessity of mutual coercion, they become free to pursue other goals…it was Hegel who said, 'Freedom is recognition of necessity'" (Hardin 1968). Hardin does not specify the type of external agent, solely that the external force implements mutual coercion, though historically these external forces have come in the form of state or private ownership. The notion of promoting community-based management would not be viewed as a viable option until Elinor Ostrom's work gained traction later in the century.

II. Common Management Systems

The debate sparked by Hardin (1968) began with two somewhat opposing factions: those supporting the privatization of common-property resources and those who supported the nationalization thereof. The glaring difference between these opinions is that one supports government management and one supports awarding users private rights to the CPR. There is, however, a common assumption inherent in both of these beliefs: in order for any change to occur in the system, it must come from an external source and be imposed on the system and its users (Ostrom 1990). Robert Smith combines these opinions when stating that the advantages gained from either public or private management cannot be attained simply by educating or persuading the users of a given CPR (Smith 1981). This shows the disdain for community-based management schemes, despite there being much evidence that this could in fact be a viable option, and is in many cases (Berkes 1986, Dietz 2003, Ostrom 1990). This section discusses the main differences between the three regimes with subsequent examples of each. The following section identifies common themes prevalent in successful community-based CPR management schemes.

The divide between private and public management is founded in the inherent presence of incentives. By determining who is motivated to do what and why, people have attempted to answer the question, "Why is Hardin's tragedy of the commons true, and what system has the best opportunity to counteract this behavior?" It is an economic convention to assume that all users are rational beings that will seek to maximize personal gains. This assumption means that users will act according to self-interest at all times, though dependent on their respective systems. Smith (1981) states, "Whenever and

wherever there have been incentives to overharvest or deplete wildlife, it has taken place, whether by primitive or modern man." This phenomenon can be seen in Figures 1.1 and 1.2. Figure 1.1 shows that fishing effort would increase as those not previously using the resource enter the fishery in order to claim a portion of the profit. The increase of fishing effort will result in the rent dissipation of the CPR. The purpose of a management regime is to allocate effort in order to maximize the resource rent of the CPR. Restricting effort would in turn protect the resource stock because the fishermen would be harvesting less than the maximum sustainable yield.

Advocates for private ownership believe that once given ownership of a CPR, an individual user's incentives will become more concerned with the preservation of the resource. "Adopting a property system that directs and channels a man's innate self-interest into behavior that preserves natural resources and wildlife will cause people to act as *if* they were motivated by a new conservationist ethic" (Smith 1981). Private ownership grants a specific user or users full access to the economic value of the resource. By decreasing the user's discount rate, there is no longer a race to harvest as many resource units as possible (Smith 1981). Privatizing allows users to factor the future of the CPR into their appropriation because they no longer have to extract the resource units *before* someone else does. It is believed that lower discount rates, therefore, allows users to avoid the issue of rent dissipation and the tragedy of the commons.

A successful case of privatizing a resource can be seen in the example of Iceland's common eider[5], a source of food and especially of valuable down feathers (Smith 1981). In the late thirteenth century, local users were awarded property rights to

[5] A common eider is a large sea-duck that inhabits the northern coasts of Europe, North America and Siberia.

the eiders living on their respective lands. The farmers would collect the down feathers after the mother eider uses them to insulate her nest. Had property rights not been established, the only way to capture any rent from the eider down would have been to kill the birds and pluck the feathers directly, because it would not be efficient to wait for the birds to build and line their nests. By giving farmers the rights to eider populations inhabiting their respective properties, the farmers had an incentive to maximize their potential profits by keeping the birds alive, so as to indefinitely collect from as many birds as possible. Users' incentives here were altered from capturing as many birds as possible to preserving and growing the number of birds inhabiting their property.

Supporters of state intervention believe that public ownership is aligned more consistently with the interests of the general public than is private ownership. Norman Myers (1979) attributes the decline of many species to the free-market, private ownership, because it "sometimes favors the here-and-now needs of private individuals to the detriment of long-term needs of the community in general." The argument can be taken one step further in that Hardin states that no entity acting in self-interest will fail to take advantage of the commons, regardless of whether the CPR is privatized or nationalized. David Ehrenfeld (1972) states, "If private interests cannot be expected to protect the public domain, then external regulation by public agencies, governments, or international authorities is needed." These excerpts show that the nationalization movement focuses on the shortcomings of privatization in relation to the wellness of the entire community, not specifically the users and resource. Incentives from private management, therefore, are still centered on personal gain, whereas those stemming from public management benefit the entire community.

There are two examples of nationalization that employed contrasting nationalization techniques with mixed results. The Turtle Island municipality is located in the Philippines, and its inhabitants are supported mainly by harvesting the eggs of indigenous turtles. Throughout the 1980s and 90s the community, with the help of external actors, organized a governance system to manage the local turtle population[6]. The system was very successful as the percentage of eggs conserved increased from about 50% in 1984 to 80% in 1999. In 2001, the Philippine government passed several laws making the harvesting and selling of turtle eggs illegal in the Turtle Island municipality. The legislation was passed, despite the fact that the local community attributed 90% of its total revenue to turtle eggs (Lejano and Ingram 2007). The new laws also made the municipality a protected wildlife area, transferring jurisdiction of the resources and land to the Philippine government, subsequently causing the existing governance system to collapse. The fact that the Turtle Island locals relied almost exclusively on harvesting the turtle eggs for income, combined with their new illegal status, created a black market for these eggs. It was reported that within a year the turtle egg conservation rate dropped from 80% to 40% (Lejano and Ingram 2007). The new government regime lasted only a few years before the municipality began attempts to recreate the system in place during the 1980s and 90s.

Elinor Ostrom and her colleagues' research on CPRs helped to transform the third management regime, community-based management, into a viable management option. This management system has become known as adaptive governance (Berkes 1986, Dietz et al 2003, Sterner et al 2006). What separates this system from privatizing and nationalizing is the initial assumption that users are *not* trapped in a situation of rent

[6] This governance system will be discussed in the greater detail throughout the following section.

seeking. Adaptive governance instead assumes that they *could* be educated or persuaded to change their appropriation techniques, consequently altering their incentives. Not only is there no *optimal* regime, there is also no guarantee that any of the three regimes will be successful or not because there is never a true, accurate precedent for a given CPR. There are many factors that must be considered about each CPR, including the domestic versus foreign demand for the resource, its location, the number of people harvesting the resource and their economic and sociological backgrounds.

One of the main arguments for public or private ownership is that users *need* help from external forces. Assuming help is necessary implies that the external agents know better, but who could know more about the overall system than those who are actually part of it? The goal of adaptive governance is to create unique institutions for a CPR system based on the local knowledge of the users, rather than impose a management regime on a CPR based on the relative success of some other CPR, related or not (Lejano and Ingram 2007, Sterner et al 2006). There is a greater likelihood that users' incentives will be changed when adhering to internally devised institutions customized to their respective situations, compared to institutions imposed upon them (Ostrom 1990, 1999). This is not to say that external agents cannot help improve management systems, but rather that the focus must be on incorporating the CPR users. Ostrom states, "Many successful CPR institutions are rich mixtures of 'private-like' or 'public-like' institutions" (Ostrom 1990).

An excellent example of an adaptive governance system is the case of the Philippine Turtle Islands during the 1980s and 90s. In the early 1980s a group of conservationists from the Philippine Department of Environment and Natural Resources

was sent to the Turtle Island municipality to improve the conservation of turtle eggs, a delicacy in Taiwan and other Asian regions. These conservationists, known as the Pawikan Conservation Project (PCP), wanted to create a system that would allow local users to continue to collect the resource rent from the turtle eggs while simultaneously increasing the conservation rate of the eggs. The PCP was able to employ local experts as wardens to monitor, and use local knowledge, such as these experts, the mayor, and council members, to devise a proper management system. The PCP system took several years to really take effect, but the conservation rate steadily increased from 50% in 1984 to almost 80% in 1988, and continued to fluctuate between 70% and 80% until the turn of the century. When the CPR was nationalized in 2001, it took only one year for the conservation rate to drop to about 40% (Lejano and Ingram 2007). The measures taken by the PCP show that external agents can assist in creating a community-based management system, and that users can be taught to change their incentives.

III. Definition of Management Framework

After examining many CPR management regimes, Ostrom defined eight design principles that were prevalent in most but not all of the successful regimes, further pointing to the fact that there is not one correct method to managing the commons. Before outlining these eight principles, however, it is important to discuss two characteristics inherent in all of the communities with successful regimes: appropriators must be able to work together, and they must have easy access to information about their respective CPRs. Regardless of which combination of the principles is actually utilized,

these two characteristics must be present in order for Ostrom's management framework to have any effect.

The term "information" here refers to information concerning "stocks, flows, and processes within the resource systems being governed, as well as about the human-environment interactions affecting those systems." (Dietz et al 2003) By working together, appropriators are able to pool their knowledge on the resource, whether it be a fishing ground or pasture. The alternative is to succumb to external agents imposing management systems based on their comparatively little local knowledge. If appropriators can collaborate with each other, they will be able to minimize costly and timely dealings with external groups. The presence of easily accessible information is an extension of working together because, as appropriators collaborate, they will inevitably share information among themselves. This will decrease uncertainty about the resource among its users and further enhance their ability to join forces and exclude external parties. Both of these factors will be discussed further as Ostrom's framework is explained.

1. *Clearly defined boundaries*

The first step outlined by Ostrom in creating an effective management regime is to clearly define the boundaries of the given CPR. This aims to solve the biggest problem with this type of resource: determining which individuals have the right to extract resource units from the CPR. Once this access problem is resolved, the discussion of proper management can shift from, "Who has access to a given CPR?" to "How should the actual management regime be constructed?" Notice that the first principle focuses on

the individual users, rather than the governing body, who are either internal or external to the local community.

The Montagnais Indians of Quebec and Labrador were successful in creating a management system for beavers until it was undermined by the invasion of the white trappers in the 1800s. Though this case is an example of privatizing a CPR, there are many aspects of the management system that help to explain some of Ostrom's design principles. Before the 1600s, the Montagnais hunted much of the wildlife in their region with little regard for conservation because it was unnecessary. When the French trappers began expanding into their territory in the 1600s, however, the Montagnais realized something must be done to protect the declining beaver population because demand for beaver furs was increasing rapidly. They were able to successfully create a system of property rights, which allowed for more efficient monitoring. By awarding themselves property rights to the beaver population, they were defining the boundaries of the CPR and limiting who was allowed to harvest the resource. This system was successful for most of the eighteenth century, until the white fur traders arrived in the nineteenth century and totally disregarded the Montagnais's system (Smith 1981). Because the Montagnais were unable to exclude the white trappers who were taking advantage of the their conservation practices (i.e. daily limits on furs), the natives were forced to scrap their property rights system and join the white trappers in exploiting the resource.

Another form of defining boundaries for a CPR is the technique used in the Philippine Turtle Islands. The PCP distributed harvesting permits to local families. Allocating permits is different from the case of the Montagnais because families were not given discrete sections of land to harvest from but rather had the right to harvest turtle

eggs *x* days of the year (Lejano and Ingram 2007). Both examples have the same goal though the techniques are different: by awarding rights to a CPR to a group of people, these individuals will have a greater incentive to maintain this resource for sustained benefit than if the CPR was available to anyone.

2. *Compatibility between appropriation and provision rules and the local community*

The second principle states that there must be compatibility between appropriation and provision rules and the local community. "Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, materials, and/or money" (Ostrom 1990). The users of the resource can take what is sufficient for the local community, but only in ways permitted by the governing body. This principle refutes the idea that there could be one management system implemented across all CPRs and reinforces the notion that each CPR, no matter proximity or similarities, is different and should be treated as such (Berkes 1986, Sarker and Itoh 2003, Sterner et al 2006).

In the case of the Montagnais Indians and the beaver, there were various appropriation rules that took both conservation and the Indians' needs into account. The Indians would split their territories into quarters with a reserve section in the middle, and they would rotate between sections each year while not touching the reserve area unless absolutely necessary. In addition, they employed a method of sustained yield harvesting so as not to harvest too many beavers (Smith 1981). This allowed them to harvest what was necessary but not too much, as well as ensure the long-term survival of the CPR by only hunting certain areas at a given time.

The Turtle Island municipality was able to employ a similar system of sustaining both the local residents and the resource rents. The families in the Philippine Turtle Islands attributed 90% of their income to turtle eggs, and the community was able to sustain an egg conservation rate of 70-80%. This period's conservation rates were 20-30% higher than before the PCP management system was implemented and 30-40% higher than a year after the system's collapse due to nationalization. The appropriation rules for each island within the municipality were that local users could harvest 60% of the total number of eggs, 30% of the eggs were to be left untouched in the turtle nests, and the remaining 10% were collected into a conservation area. The two islands with the highest yield of turtle eggs were excluded from harvesting (Lejano and Ingram 2007). The PCP implemented appropriation rules that coincided with the interests of the CPR users: the 60% harvest rate was sufficient to support the needs of the community; and not harvesting from the two highest-yielding islands was also in accordance with the local tradition that holy men were buried on these islands and should therefore be left alone (Lejano and Ingram 2007). Had the PCP not been as integrated in the community, appropriation rules may not have fit the community as well as they did.

3. *Collective-choice agreements*

The presence of collective-choice agreements is the next principle outlined in the framework. Collective-choice agreements give power to the appropriators by giving them a voice in determining the rules governing their respective CPRs. If a rule is passed and later determined by the appropriators to be ineffective, they will be given an opportunity to voice their opinions on the matter. This policy helps to customize each management regime based on local knowledge of the CPR (Ostrom 2009). It also works to prevent a

division between the users and the governance system, something that all government regimes try to avoid. Such a division would undermine management and lead appropriators to rebel against the system.

Collective-choice agreements can be seen in the PCP system in the Turtle Islands, in the sense that the community was involved wherever possible in creating management policies. There were members of the municipality known as “egg probers” who were experts in locating turtle nests and extracting the eggs, and the PCP chose these experts to act as the wardens of the CPR (Lejano and Ingram 2007). As mentioned above, the PCP also consulted the mayor and municipality council members on the appropriation rules and how to best allocate the permits to the local families dependent on the resource. The mayor and council members were later given primary responsibility for this permit system. The presence of collective-choice agreements is also demonstrated in that the PCP did not institute a set of rules that immediately led to high conservation rates; the system took several years to take hold before egg conservation rates rose substantially. The process of adapting to the community in such a way that encouraged conservation while at the same time continuing to support the municipality shows that the PCP was working with the local community to determine the optimal management system for that CPR.

4, 5. *Monitoring and Graduated sanctions*

The following two principles both work to monitor the CPR while avoiding the division between governance and the appropriators. The monitors of the CPR are either held accountable to, or simply are, the appropriators. Users who do not follow either appropriation or provisional rules are subject to graduated sanctions, while the severity,

or lack thereof, depends on the specific infraction, rather than having set punishments for first-time offenders, and so on. The goal of these policies is best described by Margaret Levi's (1988a, ch. 3) term, "quasi-voluntary compliance." Though Levi was describing the behavior of taxpayers in systems where compliance is widely followed, this same behavior can be seen in CPR systems where appropriators follow the rules. In the taxpayer example this term refers to a scenario where an individual knows that he or she *could* choose to not pay taxes, but knows that, if caught, he or she will be subject to punishment. Each individual also knows that his peers are faced with the same decision. This leads to Levi's argument that individuals will comply "when they perceive that the collective objective is achieved, and they perceive that others also comply," which is known as contingent behavior. The presence of this contingent behavior, therefore, leads the taxpayers, or appropriators of a CPR, to act with quasi-voluntary compliance (Ostrom 1990, 1999).

With respect to monitoring a CPR, quasi-voluntary compliance is important because the appropriators will effectively monitor themselves. It is expected that *if* a peer is not compliant that he will most likely be caught and consequently face punishment. Making monitors accountable to their respective appropriators, as well as user quasi-voluntary compliance, acts to remove the potential division between monitors and appropriators; the division could cause the latter to feel as though the monitors are out to get them, causing them to act in secrecy and avoid the monitors. The prevalence of easily accessible information is crucial for this system to work, because the more uncertainty concerning the motives of peers and monitors that is present, the more likely users are to act in their own self-interest.

Monitoring techniques, as do the other aspects of this framework, differ substantially between CPRs. The difference is largely determined by whether users are awarded private property rights to the resource or if they are awarded permits to harvest the resource. The former situation generally leads to self-monitoring as seen in the case of the Montagnais Indians. These people were responsible for monitoring their own parcels of land, which came in the form of retaliating against poachers and trespassers and killing beaver predators. The latter situation is exemplified in the turtle egg CPR where each local family was given access rights to the resource. Those in charge of monitoring the CPR were the local turtle egg experts, giving them an advantage over potential poachers. One method of sanctioning uncooperative users was to bring them shame through informing their respective elders of their actions. The other more serious punishment involved assisting PCP members with conservation activities for one month (Lejano and Ingram 2007). Both of the punishments acted to shame the offenders, as the monitoring system depended on this notion of quasi-voluntary compliance.

The presence of graduated sanctions can also be seen in how the wardens handled poaching during certain parts of the year. There were certain times when it was understood within the community that an individual or family may need extra income; when there was a death in the family or during the Hara Raya Puasa[7] families may need extra income for the mourning period or to travel to the place of their birth. When wardens patrolled during these times, they would give warnings and avoid confrontation with the poachers because it was understood that this was an unusual occurrence. If they were to punish these poachers it would undermine their authority because the entire

[7] Hara Raya Puasa is the time of the year when Muslims must visit their place of birth.

community would know what motivated the offense and consequently take the side of the poachers.

6. *Conflict-resolution mechanisms*

The sixth design principle is the presence or availability of conflict-resolution mechanisms. This follows the previous two principles – once a user is apprehended there must be a system to levy the graduated sanctions, whatever the arena may be. This system should be speedy, low-cost, and consistent so as to best serve the CPR as a whole and further decrease uncertainty. This could take the form of a formal court system, but in many cases of smaller CPRs, users solve their problems at a local coffee shop or other small communal area where coercion is the primary enforcer.

7. *External recognition of existing management system*

The seventh principle is that external governments must recognize the management regime of a given CPR. This is to ensure that users foreign to the CPR community cannot extract resource units without being subject to the sanctions from the CPR management regime. If this were to happen, it would completely nullify the implementation of a management system because the local users would see this infraction go unpunished and begin to question how many appropriators are not conforming to the rules.

Both the Montagnais Indians and the Turtle Island municipality fell victim to external governments neglecting to recognize their existing management systems. The white trappers were allowed to invade the Montagnais territory and harvest beaver furs with no repercussions from the trappers' government. The white trappers completely undermined the conservation efforts of the Indians, leading to the unraveling of the

management system and consequently the dissipation of resource rent from the beaver population. In the case of the Turtle Island municipality, the national government failed to recognize that the existing management system had been successful in sustaining high conservation rates for over a decade. By nationalizing the CPR, the Philippine government, in this case acting as an external government agency, completely undermined the management system by transferring jurisdiction away from the PCP and local wardens. In doing this, the government ignored the fact that the community relied on the harvesting of turtle eggs for income and gave the community no choice but to poach the CPR.

8. *Nested enterprises*

The eighth and final principle is the creation of nested enterprises where "appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers"(Ostrom 1990). This not only distributes power throughout the system but also allows certain positions or groups to focus on specific aspects of management (Ostrom 2009). Within this principle, Ostrom specifies that it is best to create these institutions from the bottom up; start at the appropriator level rather than trying to implement an overarching management regime before making sure the appropriators are on board with the changes. The purpose of this nuance is to again give more power to the appropriators in defining the management regime.

Adaptive governance systems are not created overnight and are in a continuous state of trial and error. An adaptive governance system can be implemented by those within the community or with help from an external agent. Many of the adaptive governance systems created by the users without external help have been in place for

many generations. In contrast, newer adaptive governance systems have needed external help, such as the Philippine Turtle Island users and the PCP. The need for external help in such cases stems from the need to incorporate more intensive scientific information than may be available to the users. The new form of adaptive governance, using external help, is designed to combine local knowledge with the scientific data available. This combination allows management to create rules that will hopefully sustain the resource rents for the users while also conserving the resource for the long-term. The benefit of using local knowledge is that if a rule is instituted that does not seem to be working properly then the system will adapt to whatever works best. It is not a speedy process nor was it ever intended to be. "We need to recognize that governance is frequently an adaptive process involving multiple actors at diverse levels. Such systems look terribly messy and are hard to understand. The scholars' love of tidiness must be resisted. Instead we must develop better theories of complex adaptive systems…" (Ostrom 1999). There are obviously many factors that play into how a management regime is determined, whether by internal or external forces, but in many cases the discussion is initiated due to a supposed run on a given resource which causes the focus to be on the symptoms of the problems rather than the actual causes (Sterner et al 2006).

IV. Case Studies of the North Atlantic Bluefin Tuna and Swordfish

International Commission for the Conservation of Atlantic Tunas

The two CPRs examined below are the North Atlantic Bluefin Tuna fishery and the North Atlantic Swordfish fishery. These are two of the thirty species, managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). ICCAT was

initially created in 1966 and currently has forty-eight contracting member countries. ICCAT meets annually in order to recommend conservation and management measures for bluefin tuna and other highly migratory species in the Atlantic Ocean, the Gulf of Mexico and the Mediterranean Sea. ICCAT recommendations and resolutions may include total allowable catches, sharing arrangements for member countries, minimum size limits, effort controls, time/area closures, trade measures, compliance measures, and monitoring and inspection programs[8]. The Standing Committee on Research and Statistics (SCRS) is the group that provides scientific advice to ICCAT. The main task of the SCRS is to ensure that the most up-to-date and complete statistics pertaining to the governed regions, including stock assessments of all tuna or tuna-like species, are always available to ICCAT. The SCRS also coordinates multinational research projects on these same species. This allows ICCAT the opportunity to make all recommendations and resolutions based on current statistics and information. The largest criticism of ICCAT is that it can only make recommendations; regulation enforcement is left to each country's government. In the United States the fisheries are governed by the National Marine Fisheries Service (NMFS), but in the case of the European Union, a collaboration of countries must work together.

North Atlantic Bluefin Tuna Fishery

The bluefin tuna industry, as we know it today, began in the 1960s, and by the end of the decade it was clear that some form of management regime was necessary. Prior to the 1960s bluefin tuna made up a portion of the medley of fish used for the

[8] National Marine Fisheries Service Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan, 2006.

canned tuna fish market, however, as consumers developed a taste for bluefin tuna, its commercial value began to rise. As refrigeration techniques progressed in the 1970s, tuna that once could only be sold in the domestic market were now available to international markets. The majority of bluefin shipped internationally went to Japan where the demand was and has continued to be greatest. Even earlier, it was evident among policymakers and scientists that there was a growing need to manage the fishery, and in 1967 ICCAT was founded.

ICCAT's presence in the fishery has grown substantially over the past forty-six years and now manages thirty different species of fish. However, the case of the bluefin tuna has been the least successful of all. Soon after its creation, ICCAT divided the North Atlantic bluefin fishery at 45°W longitude into two separate fisheries: West Atlantic, which includes the Gulf of Mexico, and East Atlantic, which includes the Mediterranean Sea. Since the early 1990s there has been disagreement with West Atlantic fishermen (Canada, Japan, United States) and the ICCAT management regime over decreasing quotas. After ICCAT finally adhered to scientific recommendations to decrease the total allowable catch in the East Atlantic/Mediterranean region, this sentiment spread east across the Atlantic and into the Mediterranean region. Some countries in the bluefin tuna fishery made several attempts to list the species with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), yet the countries more reliant on the resource quickly blocked these motions[9]. The tumultuous history of this management regime suggests that improvements could be made.

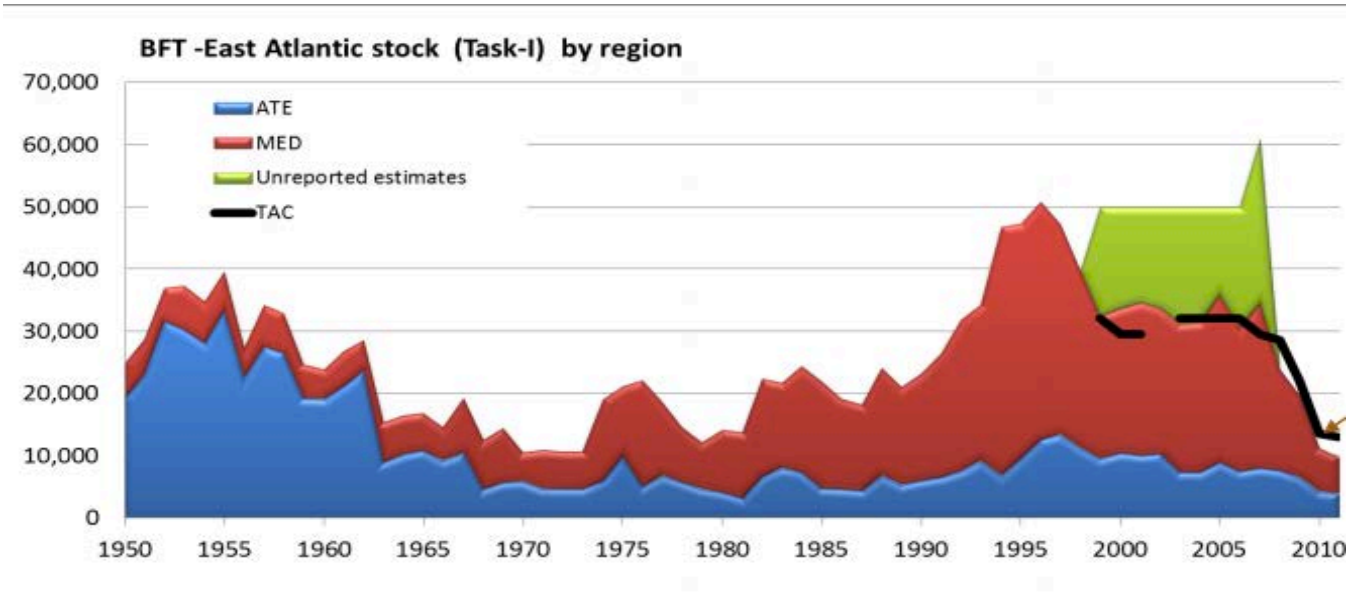
[9] These attempts are discussed in greater detail later in this section.

The East Atlantic fishery is composed of many more countries than that of the West[10], and therefore is inherently more difficult to manage. Despite the difficulty of managing so many countries, many believe that ICCAT allowed the fishery to run rampant until 2007. From 1980 to the mid-to-late 1990s, total reported catches for the East Atlantic rose from 9,000 to 40,000 metric tons (mt) per year. Between 1997 and 2007 the total reported catch leveled off between 30,000 and 35,000 mt. SCRS began recommending quotas for the East Atlantic fishery in 1997, though ICCAT did not strictly adhere to these recommendations until 2010. Between 1997 and 2003, ICCAT's total allowable catch was about 5,000 mt more than that recommended by SCRS with the largest difference of 7,925 mt coming in 2002. SCRS reports continued to show that these levels of catch were not sustainable, and in 2004 SCRS dropped the recommended total allowable catch by almost half, to 15,000 mt. The total allowable catch remained at 15,000 mt until 2010 when it was dropped even further to 13,500 mt. ICCAT, however, chose to ignore the SCRS recommendations and kept the total allowable catch at 32,000 mt for 2004-2006. In 2007 ICCAT began to lower the total allowable catch but not significantly: 29,500 mt in 2007, 28,5000 mt in 2008, 22,000 mt in 2009, and finally to the recommended level of 13,500 mt in 2010 **(**ICCAT 2012**)**. This shows mismanagement on the part of ICCAT because they completely disregarded the advice stemming from the scientific data. Because ICCAT member states send delegates to each meeting, this mismanagement most likely is rooted in protecting the fleets harvesting the resource from economic losses. ICCAT's quota allocation, however, contradicts the main

[10] The East Atlantic fishery includes those from the Scandinavian countries to those of Northern Africa that border the Atlantic, as well as all countries bordering the Mediterranean. The West Atlantic fishery includes those from Canada to South America bordering the Atlantic and Gulf of Mexico, including Caribbean countries.

goal of management to sustain the CPR for long-term use so that these same fleets will be able to continue harvesting.

Figure 4.1[11]:



The total reported catch has followed the downward trend of the ICCAT quotas. There have been years though where the total reported catch exceeded the allowable catch. The first time that the total reported catch for the East Atlantic fishery did not exceed ICCAT's total allowable catch came in 2002, six years after quotas were initially allocated. From 2002 to 2004 the reported catch was less than 1,000 mt below the total allowable catch, and in 2006 it was about 1,300 mt below. In 2005 and 2007, however, the reported catch exceeded the quota by 3,845 mt and 5,016 mt, respectively. Since 2007, even with the decline of quotas, the difference between reported and allowed catch has increased. If the stock were abundant, one would expect that the quotas would be met, yet this has not been the case. Between 2007 and 2008 the total allowable catch

[11] *ATE* represents the East Atlantic region minus the Mediterranean. *MED* represents the Mediterranean region. *TAC* represents Total Allowable Catch.

decreased from 29,500 mt to 28,500 mt, but the total reported catch fell from 34,516 mt to 23,849. In the following years the reported catch has continued to drop, reaching 9,779 mt in 2011. This verifies the concerns of SCRS and shows that despite ICCAT's recent attempts to curtail bluefin catches, the overfishing that was allowed has been detrimental to the stocks.

SCRS has also stated that there may be a large amount of underreporting[12] that has occurred in the region since ICCAT began issuing quotas. According to the PEW Environmental Group, a recent study estimated that the actual catch in the Eastern Atlantic fishery exceeded the total allowable catch by 62% between 2005 and 2011; this figure increased to 77% for the subsample of 2008-2011 (Bard 2012). Examining the trade data in 2008, the quantity of bluefin tuna exported from this region was 31% larger than ICCAT's total allowable catch, and this discrepancy grew to 141% in 2010, despite not meeting the total quota for the East Atlantic region (Bregazzi 2011). One interpretation of these findings is that following improved enforcement and trade measures adopted in 2008, countries have had a larger incentive to underreport or forge catch documents due to the implementation of stricter regulations. Bregazzi (2011) outlines three major loopholes remaining in managing the East Atlantic region: the under-reporting and non-reporting of bluefin tuna caught and transferred into bluefin tuna farms; the use of illegal gear types, namely the rampant use of illegal drift nets among the Italian fleet; and the forging of bluefin tuna catch documents which are required for trade[13].

[12] Shown by the green area in Figure 4.1.
[13] The bluefin tuna catch document is intended to trace the fish from where it was initially caught to where it is finally consumed.

The under- or non-reporting problem is centered on the rise of bluefin tuna farming. Tuna farming began in the Mediterranean in 1997 and has since grown rapidly due to the ability to determine when fish are sent to the markets. In 1998, the bluefin tuna farming capacity in the Mediterranean was less than 5,000 mt, but this number soared to 62,742 mt by 2009. During this same time the Mediterranean purse seine[14] fleet has expanded its capacity by about 35.5% (Bregazzi 2011). The fact that the farming capacity in 2009 was almost three times the total allowable catch for the region is of great concern because though purse seine gear is the only gear viable for farming, this is not the only type of fishing gear used in the Mediterranean.

The concern stems from purse seine fleets targeting schools of juvenile bluefin tuna[15]. Once captured this live school of juveniles is transported to the tuna farms, which consist of large pens out at sea, where the tuna are grown and fattened before being harvested. The juveniles are targeted because this allows the tuna farmers to have more control over the size of the fish once harvested. Juvenile tuna also tend to school much more than adult bluefin who tend to travel in much smaller groups, allowing a large number of juvenile bluefin tuna to be caught at once. Current farming operations state that this method will help to solve the issue of overfishing, however, by definition these farms target juvenile fish (Sumaila, 2011). This poses an enormous problem for the wild stock because fewer bluefin tuna will even have the opportunity to mature to the spawning age.

[14] Purse seine gear, sometimes towed by two boats, is essentially a large net that encloses a school of fish and then is drawn shut at the bottom, trapping the entire school. It is also the only viable option for transporting tuna to the tuna farms.
[15] Juvenile bluefin tuna refers to those that are not old enough to spawn.

Management of the East Atlantic bluefin tuna has traditionally favored the fishermen over conservation efforts. This is largely due to the number of countries involved in this fishery but can also be attributed to Japan, the final destination for much of the world's bluefin tuna. Japan's demand for bluefin tuna is unmatched as the country consumes an estimated three quarters of the annual bluefin catch for the entire world (Harden 2010). This constant demand is what has driven the growth of the tuna farms. Since bluefin tuna fishing is not permitted in the East Atlantic fishery year-round, these farms allow the fishermen to send fish to market during the off-season or simply when prices are best.

Though not acting alone, the Japanese government has been heavily involved in blocking the addition of bluefin tuna to the CITES endangered species list multiple times. In 1991 in response to ICCAT and the NMFS reports stating the stock's decline in abundance, the National Audubon Society proposed listing the West Atlantic bluefin under CITES Appendix I which would cause the international trade of the species to be banned. NMFS and the U.S. Fish and Wildlife Service supported a listing with CITES but advocated for the less restrictive Appendix II listing (Wagner 1996). Both of these attempts fell short, however, due to the U.S. government backing of the ICCAT regime, not wanting to undermine the current management system. The following year Sweden attempted to list the West Atlantic bluefin under CITES Appendix I and the East Atlantic stock under CITES Appendix II, yet this attempt was blocked, this time due to heavy lobbying on the part of Japan with support from Canada, Morocco, and the U.S. A few years later in 1994 Kenya suggested that both East and West Atlantic stocks and southern bluefin tuna stocks be listed under CITES Appendix II. Japan, who at the time sent over

$100 million to Kenya annually in the form of economic aid, again blocked this listing because they viewed it as threatening to Japan's national welfare (Wagner 1996). In 2009, the U.S. government finally announced that it would support a ban on the international trade of bluefin tuna. Though this was never implemented, Japan made it very clear that it would not support the ban. "'If worst comes to worst, Japan will have no choice but to lodge its reservations,' Masahiko Yamada, a vice minister who oversees fisheries, told reporters" (Harden 2010).

The East and West Atlantic bluefin tuna fisheries, especially the former, have consequently been locked into the "tragedy of the commons" problem. In recent years, ICCAT has attempted to curtail production by decreasing the quotas, yet it is clear from the data that it has fallen short. One significant reason for this is that ICCAT does not have jurisdiction over every fleet harvesting the stock. Each country is responsible for its respective fleets, making it especially difficult for management to deal with the issue of flag-of-convenience vessels[16], as well as countries that are not ICCAT members. Another problem is that the major player in the market, Japan, refuses to support ICCAT's recent push for conservation. As a result, there is no action being taken to curb the demand for bluefin; management can continue to try to cure the symptoms of the problem but this will not be effective until the demand problem is dealt with. The ever-increasing Japanese demand then creates a situation that encourages illegal and unreported fishing, essentially encouraging the fishermen to remain trapped in the tragedy of the commons.

There are many discrepancies between Ostrom's framework and ICCAT's practices, but the core of the problem lies deeper than just the structure of management.

[16] Flag-of-convenience vessels are those that register in countries with less stringent regulations than that of their home country.

Inherent in the successful CPR communities studied by Ostrom are two characteristics that are absent in the North Atlantic: the ability of fishermen to work together and to easily share information. Part of this could be attributed to the expanse of the entire fishery, yet the notion that every seaside community has a stake in the fishery is far from the reality. Ostrom's successful cases were not attributed to external management regimes, but rather to the actual users of the CPR acknowledging a problem, or potential problem, and subsequently setting their differences aside to work together. In order to do this, the users were able to agree that the long-term benefits outweighed the higher short-term gains; these successful communities had low discount rates for their respective CPRs.

Over the past forty-six years there has been zero evidence that this phenomenon has even been in the realm of possibility. Though the issue of accessible information is an extension of working together, the lack thereof in this fishery shows that the fishermen are hesitant to help their peers catch more fish. This behavior stems from the concern that helping the competition could detract from their personal harvest. Until these fisherman are comfortable with the idea of each catching fewer fish in order to conserve the fishery, collective action without external intervention is a long ways off.

Within Ostrom's framework, once the ability to work together has been established, the next step is to implement the above described design principles. Implementing a new system does come with one caveat: the system works best when these institutions are created from the ground up. When ICCAT was founded, this was not a decision made by the bluefin fishermen; when ICCAT member states convene annually, the representatives are not that of the fishermen but of their governments.

ICCAT, which represents forty-eight countries, is a prime example of external actorsstepping in to manage a CPR. As seen in the bluefin fishery and the failed cases studied by Ostrom, the presence of a management regime controlled by external actors creates a disconnect between the appropriators and managers. This disconnect is caused by the feeling that the external regime is taking control of the CPR away from the appropriators. The process by which ICCAT was formed, combined with the lack of collective-choice agreements, make the fishermen feel as though they do not have control over their livelihood. In the cases where these institutions were created starting from the appropriator level, the users of the CPR initially proposed conservation efforts. In the case of the North Atlantic bluefin tuna, however, these conservation efforts were imposed upon the fishermen. Not only was the original management regime imposed upon them, but they also have no voting power in ICCAT and must expect their respective governments to act in their best interests. But how can their best interests be known if there is no forum to express these feelings? In order for an improvement to be made on this front, NMFS must devise a way to better incorporate the fishermen into policy-making.

The fishery's monitoring system is ineffective for multiple reasons and must be changed in order for there to be any improvements in the West Atlantic bluefin tuna stock. The conventional monitoring system employs individuals who act solely as monitors who then report to management. The vastness of the fishery makes the conventional monitoring system difficult to rely on. For this reason, the fishery largely depends on the fishermen being honest and reporting each fish caught to their respective governments who then report the data to ICCAT. There is nothing wrong with this honor-

based system, however, it only works if each angler believes the majority of his peers are doing the same: quasi-voluntary compliance. Because information is not easily accessible across the fishery, quasi-voluntary compliance is more difficult to attain because no angler wants to be the sole conformer to the rules. Without this compliance, management must rely on the monitors, who in the eyes of the fishermen are grouped into the category of external actors. The bias against monitors further deepens the void between themselves and management. While fishermen view monitors as external agents, the perception that they are out to "catch" the fishermen doing wrong will be ever-present. For this reason, Ostrom believes it best when the monitors report directly to the appropriators, rather than over their heads.

Another major issue within the fishery is the question of how to deal with flag-of-convenience vessels. A flag-of-convenience vessel is usually one that was originally from a country with strict regulations but then registered to a country that is less stringent. In many cases, the less stringent regulations are virtually non-existent, allowing these fishermen to abide by a different set of rules. This shows that the boundaries are not clearly defined and that not all external governments recognize the rules of the ICCAT management regime, two of Ostrom's design principles.

North Atlantic Swordfish Fishery

Swordfish are similar to bluefin tuna in that the species inhabits most of the world's seas and is an economically valuable commodity, yet there are many differences as well. Swordfish have been harvested for thousands of years in the Mediterranean and off the West Coast of North America, though it was not until the middle of the nineteenth

century that swordfish became a real commodity. Prior to this the fisheries were operated by subsistence fishermen, also known as artisanal farmers, who did not harvest more than their respective communities demanded (Berkes 1986, Ward et al 2000). For about 150 years the swordfish fishery in the North Atlantic grew and transformed with the introduction of new technologies. This growth came to a halt in the late 1980s when the lack of management was perceived to be an issue. By the turn of the century, the fishery neared depletion, and changes needed to be made. Today, the North Atlantic stock of swordfish is completely rebuilt and the recovery of the fishery is regarded as one of the great fishery management successes of recent times. This section examines the various contributing factors of what transpired in the late 1990s and early 2000s that led to the regrowth of the North Atlantic swordfish, and what has occurred since the announcement of the fishery's full recovery.

The fishery experienced major transformations during the second half of the twentieth century that ultimately led to the fear of depleting the North Atlantic swordfish. With the implementation of longlining and the globalization of the market due to refrigerated airfreight, swordfish were harvested at increasing rates through the 1980s (Ward et al 2000). Longlining, now the primary method for commercial swordfishing, is a form of fishing where many baited lines hang from a mainline[17] suspended by buoys along the surface of the ocean. Fishermen also began to chill their catch on ice and shorten their excursions, because chilled swordfish is much more valuable than frozen swordfish due to relatively good storage qualities. Swordfish prices also do not fluctuate with the quality of the fish as much as that of bluefin tuna (Ward et al 2000). Technological improvements, including what type of line to use, faster vessels, more

[17] The mainline can be up to a few miles in length.

efficient labor due to mechanized hydraulic reels, changes in hook depth, spacing between hooks, and the use of light sticks, continued to increase efficiency and catch rates in the fishery (Hoey et al 1989, Ward et al 2000). These improvements led to the expansion of the fishery, as more vessels traveling farther distances began targeting swordfish.

Similar to the North Atlantic bluefin, the swordfish fishery in the North Atlantic is very much an international fishery. By 2000, there were at least nineteen countries involved in the fishery, however it has historically been dominated by Spain and the United States, and to a lesser extent, Canada, Japan, and Portugal. The total catch peaked in 1987 at 20,236 mt, and then steadily declined throughout the 1990s, reaching it's low in 1999 with a reported catch of 11,622 mt (ICCAT 2012-2013). This decline in catch rates can be attributed to lower swordfish abundance, as well as increased regulations and the migration of vessels to more profitable fisheries. Between 1990 and 1996 the harvest rate also continued to decline, showing that this drop in total catch was not solely due to vessels exiting the fishery. There was also a growing proportion of juvenile swordfish in the population (ICCAT 2000a). The growing number of juveniles began to show as fewer and fewer large swordfish were available in the markets (Prewitt 1998). Concern over this fishery led two conservationist groups, SeaWeb and the National Resources Defense Council, to initiate a boycott on swordfish.

The "Give Swordfish a Break" campaign began in January 1998 with the hopes of spreading awareness of the problem of overfishing swordfish, especially juveniles. The campaign pointed to the longlining industry as the culprits due to their increased levels of harvesting juveniles. In 1998, almost 19% of swordfish caught in the Atlantic were

smaller than ICCAT's minimum size requirement (Ward et al 2000). In the same year, Spanish, American, and Canadian fleets estimated that their catches of undersized swordfish, including dead discards[18], totaled 37%, 32%, and 21% of their total catches, respectively (ICCAT 1999). Within six months, the boycott had about 200 supporting chefs and restaurants, and this would grow to about 700 members by the year 2000. Though the campaign was only supposed to span one year, advocates decided to extend the boycott until they deemed ICCAT and the U.S. government's response sufficient. Critics of the campaign claimed that the boycott was only hurting domestic fishermen because the ban coincided with a fall in swordfish prices in 1998 (Kronman 1999, Ward et al 2000); the potential correlation is significant because the domestic fishermen were doing nothing wrong by adhering to the rules of the fishery. The boycott was finally called off once the NMFS instituted the closure of 154,000 square miles of the Atlantic on August 1, 2000 (2006 FMP NMFS, 3-16). This closure, spanning DeSoto Canyon, the Florida East Coast, and Charleston Bump, was management's attempt to curtail the harvesting of juvenile swordfish, but also to mitigate the level of by-catch of sea turtles.[19]

The management of the United States swordfish fishery in the 1990s and early 2000s has many similarities to an adaptive governance regime. The main principle of such a regime is combining local and scientific knowledge to best adjust to ever-changing resource stocks and communities. As awareness spread in the early 1990s that there was a lack of management and stocks were declining, ICCAT began issuing quotas in 1995 to

[18] Dead discards are fish that are caught and then discarded (dead) back into the ocean, generally due to not meeting the minimum size requirement. Dead discards were not included in the total allowable catch until the late 1990s.

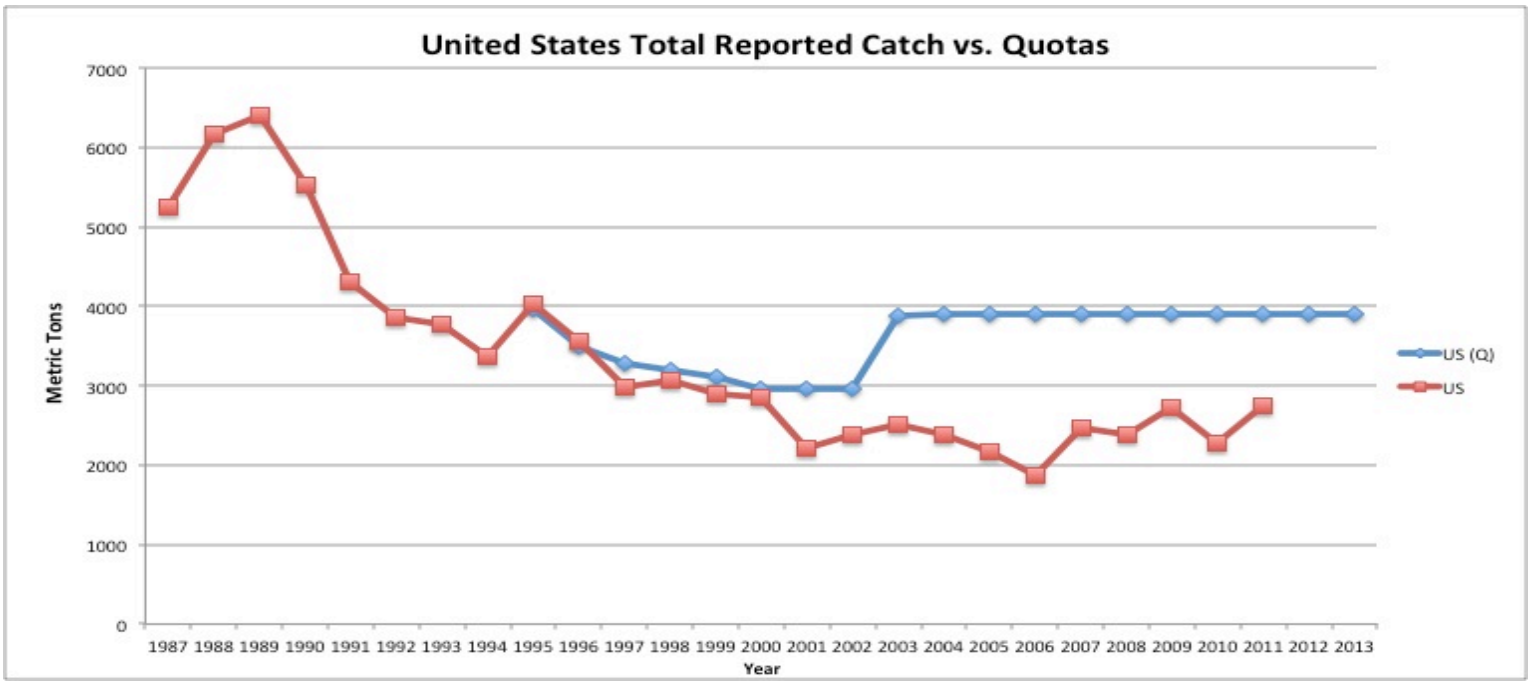
[19] Sea turtles are the primary by-catch when longlining for swordfish because of the shallow hook depths, compared to the much deeper hook sets of tuna longlining.The sea turtle by-catch in the swordfish fishery was also a huge concern for environmentalists.

the major countries involved in the fishery. Canada, Portugal, Spain and the U.S. were the first countries while Japan received its first swordfish quota in 1997. These quotas continued to decline until 1999 when ICCAT announced a rebuilding plan for the North Atlantic swordfish stock, mainly consisting of further decreasing the quotas. This was followed a year later by the large NMFS area closure. This conservation movement was backed strongly by the fishermen, even considering that the area closures were instituted separately from ICCAT's rebuilding program. The fishermen also played a large role in helping to gather scientific data on sea turtle by-catch research (NMFS FMP2006). This shows that both sides of the CPR, the users and management, were cooperating in order to determine the best strategies for governance.

This cooperation soon deteriorated as management failed to live up to their responsibilities to the fishermen. The swordfish rebuilding plan instituted by ICCAT in 1999 called mainly for a decrease in quotas over the next three years. At the end of this period in 2002 studies showed that the North Atlantic swordfish stock was improving rapidly. This prompted ICCAT to increase the US quota, but because the area closure was mandated by the NMFS, ICCAT had no jurisdiction to reopen these areas. This led to the current[20] eleven-year period during which the US fleet has failed to come within 1000 mt of its quota.

[20] Data was not available past 2011.

Figure 4.2:



Analyzing Figure 4.2, it is clear that for the first six years that ICCAT issued quotas, the US fleet was able to fulfill its quota. The year 2001 was the first time where the U.S. fishermen were drastically below their quota by 734 mt. This difference would shrink to 567 mt in 2002, yet this is the closest the U.S. fleet has come to fulfilling their quota since. In 2003 ICCAT increased the U.S. share, but without the reopening of the closed areas, U.S. fishermen were not able to take advantage of the most productive fishing grounds. Between 2003 and 2011 the total catch has been at least 1,155 mt below the quota. Since the quota has remained fixed at the 2003 level of 3,907 mt, there is clearly a discrepancy between the quota and the capabilities of the U.S. fleet, especially considering that studies showed the North Atlantic swordfish stock was rebuilt as early as 2006.

The gap between the U.S. quota and total reported catch poses an issue for the future of the U.S. fleet. When a fleet's total reported catch is below the quota, this

difference is then added on to next year's quota or vice versa, but if a fleet perpetually under-harvests, portions of the quota are subject to reallocation to other fleets. This rule was modified in 2006, so that only 50% of a country's quota could be transferred to next year's quota. The rule was changed again in 2011, so that countries with quotas of over 500 mt could not transfer more than 25% of that year's quota forward to the following year, while other countries were allowed to transfer a maximum of 50%. The higher quota, the continued closure of the prosperous fishing grounds around Florida, and the ability to transfer less of the unmet quota forward are the major factors acting to lock the U.S. fleet into a situation where their potential harvest is either going untouched or transferred away. In 2007 and 2008, 2,690 mt of the unused portion of their quota over the period 2003-2006 was added to the total allowable catch for the entire North Atlantic, divided evenly across years at 1,345 mt per year. On top of this, the United States transferred 25 mt to Canada each year from 2007-2011 and transferred 150 mt to Morocco in 2012. Though the transfer to Morocco was intended to support scientific research as well as helping to phase out the use of drift nets in the Moroccan fleet and the 25 mt to Canada does not seem like a significant matter for a country under-harvesting by over a 1000 mt, the U.S. fleet is bearing a majority of the conservation pressure. If these closed fishing grounds are indeed the most lucrative of the U.S. swordfish fishery, then by reopening them the U.S. fleet would likely harvest a larger percentage of their allocated quota. Harvesting a greater percentage would cause the conservation effort to be distributed more evenly.

Management's two overarching goals are to simultaneously protect its fishermen and corresponding fisheries. The regrowth of the North Atlantic swordfish stock is

considered to be one of the few, great management success stories for large CPRs, though this could not have been accomplished without the support and assistance from the fishermen. Though the success can be attributed to the collaboration between the fishermen and management, it should not overshadow the current eleven-year period of under-harvesting brought on by the lack of collaboration between the two groups. U.S. management is failing to protect its own fleet by failing to deal with the under-harvesting problem. If under-harvesting continues, it will result in the reallocation of resources to other fleets, essentially dissipating rent, despite the fact that the stock is abundant and not currently overfished. In order for an adjustment to be made, U.S. management must revert back to its tactics that led to the successful regrowth of the stock: adaptive governance.

V. Concluding Remarks

In determining what led the swordfish stock to regrow compared to the ever-declining North Atlantic bluefin stocks, the difference between restricted and non-restricted access is highlighted. This difference is exemplified in Figure 1.1 where it is shown that the fishing effort corresponding to maximum economic yield is less than that which corresponds to maximum sustainable yield. For this reason, a restricted access fishery has a much greater chance of recovery than an open access fishery because management is able to cap the fishing effort. This is not to say that this system allows management to determine the exact number of vessels that should be permitted; but by having such a system in place, management would have a better understanding of the

number of users involved in the fishery. The more knowledgeable the management regime is of the CPR community, the more likely it will be to implement sound policies.

High seas fisheries pose a specific problem in trying to implement restricted access systems. The problem is that there is no realistic way to partition off the high seas. It would not be possible for the U.S. government to award property rights to bluefin tuna or swordfish fishing grounds, as the Montagnais did with the beaver and the Icelanders did with the common eider. There are simply certain CPRs where it is impossible to clearly define boundaries. Many believe that the answer lies in individual transferrable quotas, which are quotas distributed[21] to individual fishermen who can then choose to harvest the resource or sell the quota to a competitor. Though this system has been successful in some fisheries, it still does not solve the problem of defining boundaries and physically excluding foreign fishermen from the resource. The debate of how to best manage a high seas fisheries will continue until a system is devised that can realistically cap fishing effort.

[21] Individual transferrable quotas are generally distributed based on historical catches. A fisherman who has historically caught many swordfish will receive a larger quota than a fisherman who has recently had a downward trend in reported catch.

Bibliography

Advanced Tuna Ranching Technologies. 2010. *Requiem for a Bluefin*. www.atuna.com/requiem.pdf.

Anonymous. "Marine Agencies Oppose Swordfish Ban, Say It's Misguided." *Nation's Restaurant Review* 6 July 1998: 8. Print.

Anonymous. "With 'Break' Over, Chefs Use Swordfish in the Kitchen Again." *Nation's Restaurant Review* 2 Oct. 2000: 41. Print.

Bard, Dave. "The Story of Atlantic Bluefin Tuna." *The Pew Charitable Trusts*. PEW Environmental Group, 5 Oct. 2012. Web. 22 Apr. 2013.

Berkes, Filkret. "Local-level Management and the Commons Problem." *Marine Policy* 10 (1986): 215-29. Web.

Boustany, Andre, Ph.D. "Bluefin Tuna: The State of the Science." *Pew Environment Group*. Pew Environment Group, n.d. Web. 1 Dec. 2012.

Bregazzi, Roberto M. "Mind the Gap: An Analysis of the Gap Between Mediterranean Bluefin Quotas and International Trade Figures." *Pew Environment Group*. Pew Environment Group, n.d. Web. 15 Nov. 2012.

Dietz, T et al. "The Struggle to Govern the Commons." *Science* 302.5652 (2003): 1907-912. Print.

Ehrenfeld, David. *Conserving Life on Earth*. New York: Oxford UP, 1972. Print.

Goldman, Rebecca L., Barton H. Thompson, and Gretchen C. Daily. "Institutional Incentives for Managing the Landscape: Inducing Cooperation for the Production of Ecosystem Services." *Ecological Economics* 64.2 (2007): 333-43. Print.

Gordon, H. Scott. (1954) The Economic Theory of a Common Property Resource: The Fishery. The Journal of Political Economy, 62, 124-142.

Gutting, Richard E., Jr. "Swordfish Boycott: Protesters Have the Right Idea but the Wrong Solution." *Nation's Restaurant Review* 16 Mar. 1998: 42. Print.
Hardin, Garrett. "The Tragedy of the Commons." *Science* 162.3859 (1968): 1243-248. Web.

Harden, Blaine. "Japan Says It Won't Comply with Bluefin Tuna Ban." *Washington Post*. N.p., 5 Mar. 2010. Web. 22 Apr. 2013.

Hilborn, Ray. "Reinterpreting the State of Fisheries and Their Management." *Ecosystems* 10 (2007): 1362-369. Web.

Hoey, J. J., R. J. Conser, and A. R. Bertolino. "The Western North Atlantic Swordfish." *Audubon Wildlife Report* (1989/1990): 457-77. Web. 15 Apr. 2013

"ICCAT Biennial Reports." *ICCAT Biennial Reports*. N.p., n.d. Web. 15 Oct. 2012.

Myers, Norman. *The Sinking Arc: A New Look at the Problem of Disappearing Species*. N.p.: University of Michigan, 1979. Print.

NMFS. Supplemental environmental assessment, regulatory impact review, and final regulatory flexibility analysis for the final 2010 Atlantic Bluefin Tuna quota specifications. U.S. Department of Commerce, NOAA, National Marine Fisheries Service. Office of Sustainable Fisheries, Highly Migratory Species Management Division: April 2010.

Ostrom, E., M. A. Janssen, and J. M. Anderies. "Going Beyond Panaceas Special Feature: Going beyond Panaceas." *Proceedings of the National Academy of Sciences* 104.39 (2007): 15176-5178. Print.

Ostrom, Elinor. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." Nobel Prize Lecture. 8 Dec. 2009. Lecture.

Ostrom, Elinor. "The Challenge of Common-Pool Resources." *Environment: Science and Policy for Sustainable Development* 50.4 (2008): 8-21. Print.

Ostrom, Elinor. "Coping With Tragedies Of The Commons." *Annual Review of Political Science* 2.1 (1999): 493-535. Web.

Ostrom, Elinor. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge UP, 1990. Print.

Prewitt, Milford. "Chefs Still on Guard about Swordfish as Species Recovers." *Nation's Restaurant Review* 4 Nov. 2002: 8. Print.

Prewitt, Milford. "ICCAT Sees Swordfish Comeback." *Nation's Restaurant Review* 21 Feb. 2000: 4. Print.

Prewitt, Milford. "Swordfish and Boycott Buzzwords at Aspen Classic." *Nation's Restaurant Review* 6 July 1998: 8+. Print.

Salvatore, Dominick. *Microeconomics: Theory and Applications*. New York: Oxford UP, 2003. Print.

Sarker, Ashutosh, and Tadao Itoh. "The Nature of the Governance of Japanese Irrigation Common-Pool Resources." *Society & Natural Resources* 16.2 (2003): 159-72. Print.

Scott, Anthony. "The Fishery: The Objectives of Sole Ownership." *Journal of Political Economy* 63.2 (1955): 116-24. Web.

Smith, Robert J. "Resolving the Tragedy of the Commons by Creating Private Property Rights in Wildlife." *Cato Journal* 1.2 (1981): 439-68. Web.

Sterner, Thomas, and Et Al. "Quick Fixes for the Environment: Part of the Solution or Part of the Problem?" *Enviornment: Science and Policy for Sustainable Development* 48.10 (2006): 20-27. Web.

Sumaila, Ussif Rashid, and Ling Huang. "Managing Bluefin Tuna in the Mediterranean Sea." *Marine Policy* 36.2 (2012): 502-11. Print.

United States. National Marine Fisheries Service. Office of Sustainable Fisheries. *Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan*. N.p.: Department of Commerce, 2006. Print.

Ward, Peter, J. M. Porter, and S. Elscot. "Broadbill Swordfish: Status of Established Fisheries and Lessons for Developing Fisheries." *Fish and Fisheries* 1 (2000): 317-36. Web.

Wagner, Brian. "Atlantic Bluefin Tuna: International Management of a Shared Resource." *Reviews in Fisheries Science* 4.3 (1996): 203-27. Print.

Webster, D.G. *Adaptive Governance: The Dynamics of Atlantic Fisheries Management*. Cambridge, MA: MIT, 2009. Print.